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DIVISION OF

TELECOMPUTING CORPORATION

3850 OLIVE STREET, DENVER, COLORADO, DUDLEY 8-4834

comp. with.

SILVER-CADMIUM BATTERY DEVELOPMENT PROGRAM

QUARTERLY TECHNICAL PROGRESS REPORT

FOR FOURTH QUARTER, ENDING 20 AUGUST 1962

DATED

14 September 1962

CONTRACT NO. NAS5-1431

John W. Rhynes

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(cont.)

Contract

OTS:PRICE

XEROX

\$

1.60 phz

MICROFILM

\$

0.80 mf.

SILVER-CADMIUM BATTERY DEVELOPMENT PROGRAM

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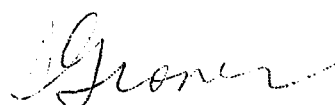
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REPORT

PHASE I - CONTAINER DESIGN AND DEVELOPMENT

Cell Case

Moisture permeability studies on the various potential cell materials have been completed. As mentioned in the Third Quarterly Report, attention was being given to the epoxy-polyamide system, possibly in conjunction with an outer layer of Saran as a moisture barrier. Four systems were evaluated:

1. Styrene
2. Styrene coated with 10 mils Saran F-120
3. Saran F-120
4. Epoxy-polyamide

Narmco Resin 3135 was chosen as being representative of the epoxy-polyamide system. All of the above materials were fabricated into rectangular cases with wall thicknesses of 0.075 inch.

Saran, of course, had previously been found to be attacked by the electrolyte, and in addition was found to precipitate free silver from an alkaline solution of the silver oxide. However, its good resistance to moisture permeability warranted its use as a reference material.

The study was made at a constant temperature of 120°F. The individual cell cases were half-filled with 40% KOH. The cases were then sealed with Resin 3135 used as the lid sealant. The moisture test results are expressed as weight loss in grams per 100 square inches of surface per day per atmosphere of pressure. Each of the four systems was run in triplicate, and the curves, Figure 1, are the averages of the three determinations. It is believed that the high values for the polystyrene - Saran coated system were due to methyl ethyl ketone being absorbed in the styrene layer during the coating operation, with a subsequent release of solvent on heating. It can be seen from Figure 1 that Resin 3135 compares quite favorably with the values obtained for the Saran F-120.

The material finally chosen for fabrication of the cell containers was an epoxy-polyamide system consisting of 60 parts of Epon 820¹, 40 parts of Lancast "A"², and two parts DTA³. This composition closely approximates that of Resin 3135. Electrochemical compatability of this material is still being studied.

The circular cell case mold has been completed and six sets of styrene cases have been made for initial construction evaluation. However, it was found that the matched metal mold could not be used as such with the epoxy-polyamide system due to the poor workability of the material, and the occlusion of voids. In addition, in spite of release agent applied to the mold, the mold could not be taken apart without fracturing the cell containers. These problems were solved by making the male portion of the mold from a silastic material. This permitted relatively good flow-out of the material, and good release of the finished case. Also, the problem of voids was minimized, but not completely eliminated. Satisfactory cell containers are now being produced, and it is expected that the quality of these parts will improve. A photograph of the present containers, made of epoxy-polyamide, is shown in Figure 2.

Cell container covers are cast as flat sheets which are then cut out to the required shape. Three epoxy-polyamide cell containers and covers have been made for testing and inspection. An additional eleven containers have been fabricated for battery container Number 10.

Container Fabrication

Battery container Number 10 is to be tested for moisture permeability and vibration: A special assembly, Figure 3, was built for this purpose. This has been designed to simulate the mass of the finished battery. Each of the eleven cell containers was packed with 1/16 inch sheets of neoprene and lead to an average total weight of 145.1 grams per cell, or a gross weight of 1596 grams for the eleven cells. Of this, the average weight of dummy packing per cell was 124.1 grams leaving an average weight of 21.0 grams for each empty cell container and lid. The end plates were 1/4 inch thick to accommodate the O'ring seal on the pressurizing shaft. However, the integrity of the 1/8 inch thick end plates has already been established by previous tests. The lids were bonded to the container with Narmco Resin 3135. The joining of containers and the end plates was also done with Resin 3135.

1 Shell Chemical Company

2 Ciba, Los Angeles, California

3 Diethylenetriamine

The eleven loaded cell containers were assembled to form the dummy battery (Number 1). Figure 4 shows this assembly, lathe mounted and ready for winding. Next, du Pont Teflon FEP film and glass roving were wound over the cell container assembly. Figure 5 shows the winding of the first fiber layer. After curling, the weight of the battery, without the shaft, was 3.90 pounds. This corresponds to a battery container weight of 0.38 pound. These values are both less than the original proposed design weights.

Figure 6 shows the finished dummy battery. Note the transparent shell which makes the cell containers visible in the photograph.

PHASE II - ELECTROCHEMICAL DESIGN

During this period six cell cases molded from polystyrene were received for use in evaluating cell construction. Using available plates, two cells were constructed with these cases. Some initial difficulty was encountered in cell assembly due to the use of the molded case instead of the fabricated cell case and cover previously employed. Electrical connection from the plates to the outside was provided by silver wire leads welded to the plate grids.

These cells are identified as cells I and J. The details of the construction are given as follows:

Number of positive plates	5
Number of negative plates	6
Area per side	4 in ²
Separator system	1 layer Dynel - non-woven 2 layers polyethylene base ion exchange membrane 2 layers modified cellophane 1 layer Dynel - non-woven

Sealing of the membrane separators around the positive plates was accomplished by the use of spacer rings which provide a pressure seal against the swellable membrane layers.

Further details of plate construction were given in the preceding quarterly report.

Test Results

Cells E and F: (Second Quarterly Report)

These test cells are still on wet stand test. The tests were not completed during the reporting period.

Cells I and J:

The cells were given initial manual cycle tests. One cell indicated an internal short circuit. The other cell operated normally. Its initial performance was very similar to that obtained from Cell G, which is shown in the Third Quarterly Report (Figure 5).

The short that developed in Cell I was due to a lead wire which became bent during the assembly. As this cell had been used to work out the assembly details and had been taken apart and re-assembled several times prior to its final seal, this was not considered to be significant for future construction.

Future Work

Battery Container:

Dummy Battery Number 1, Case Number 10, will be subjected to environmental testing. This assembly will be tested for leakage and moisture permeability. Vibration tests will be conducted per Mil-E-5272C, Procedure XIV, except that 40 g. acceleration will be used in lieu of 20 g. If 40 g's cannot be attained with available equipment, a lower level will be used but not less than 20 g's. Leak checks will be made, using a Helium - Mass Spectrometer Leak Detector, before and after each plane of vibration to evaluate any possible damage resulting from the exposure of the case to vibration. Any necessary changes will be incorporated into the design and Case Number 11 will be wound as Dummy Battery Number 2 and retested. At this time the final design of the battery assembly will be made.

Prior to the final design, information should be received from NASA as to the exact connector or terminal requirements for the battery. It was understood from prior conferences that this connector would be NASA furnished.

Electrochemical Design:

Additional cells will be constructed to further develop construction techniques. These will be made using the epoxy cell cases. The plate construction will be modified in terms of thickness and amounts of materials so as to give the most favorable ratio of active materials and thus to optimize the capacity of the cell. Upon the arrival of ordered power supplies, Cell J will be put on automatic cycle to further check on cell construction.

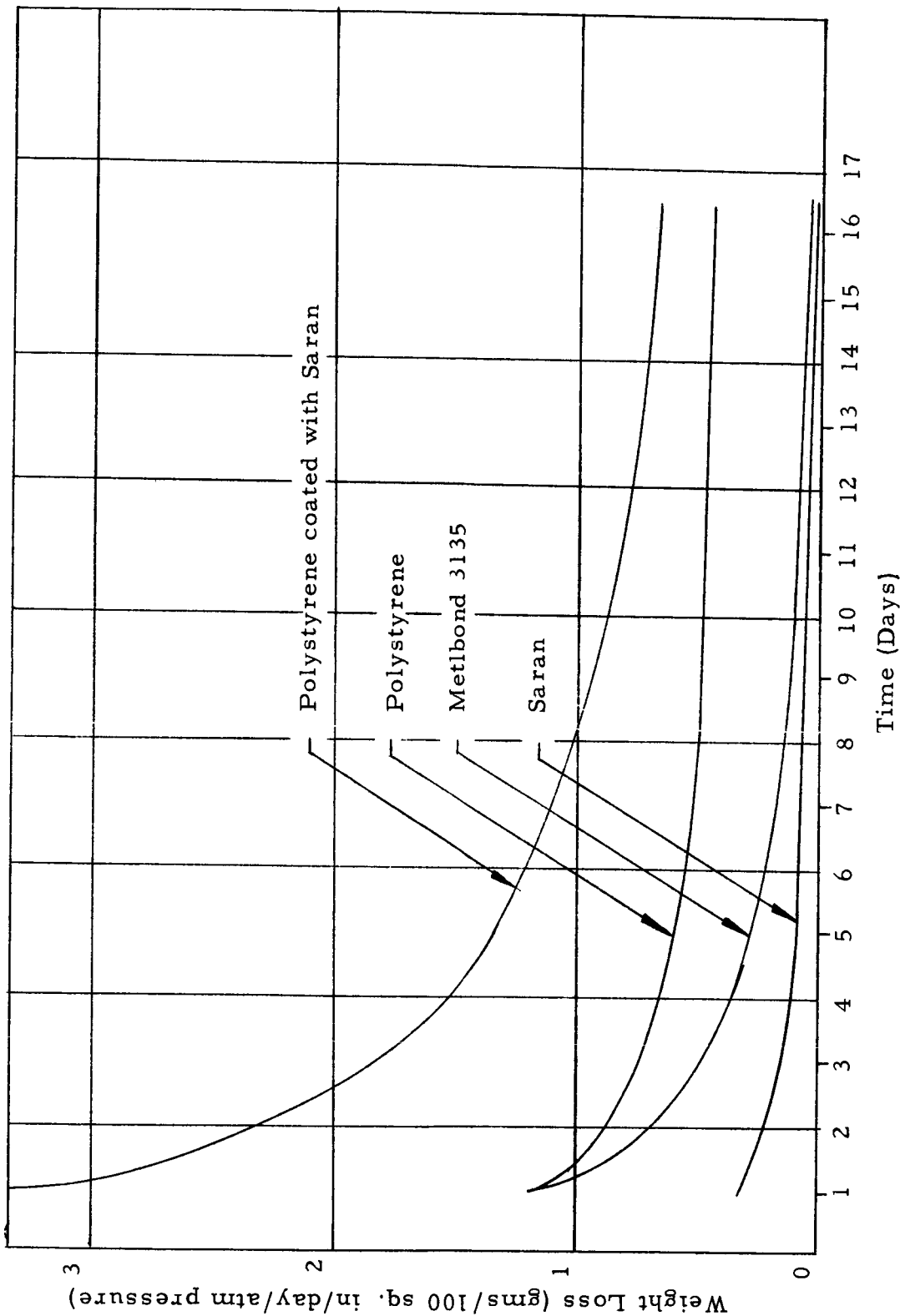


Figure 1. Permeability of Plastics for 40% KOH at 120°F

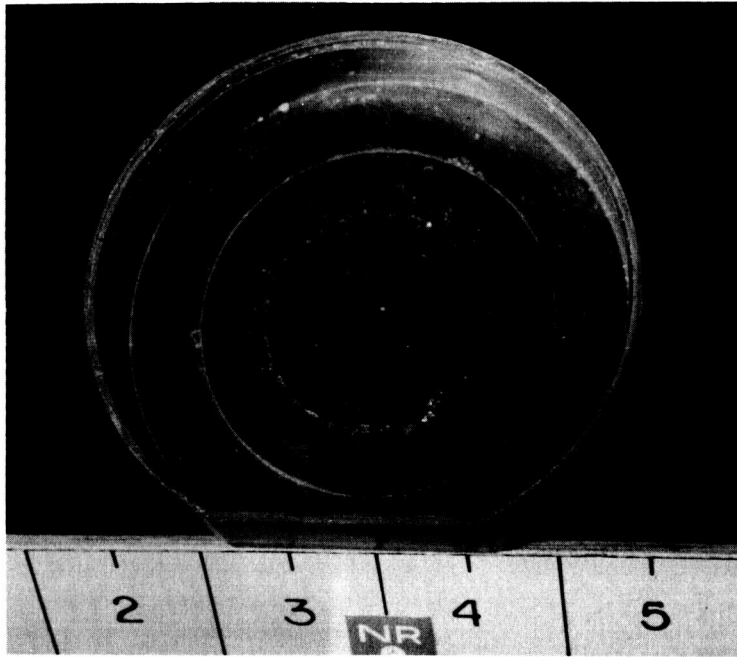


Figure 2. Cell Container

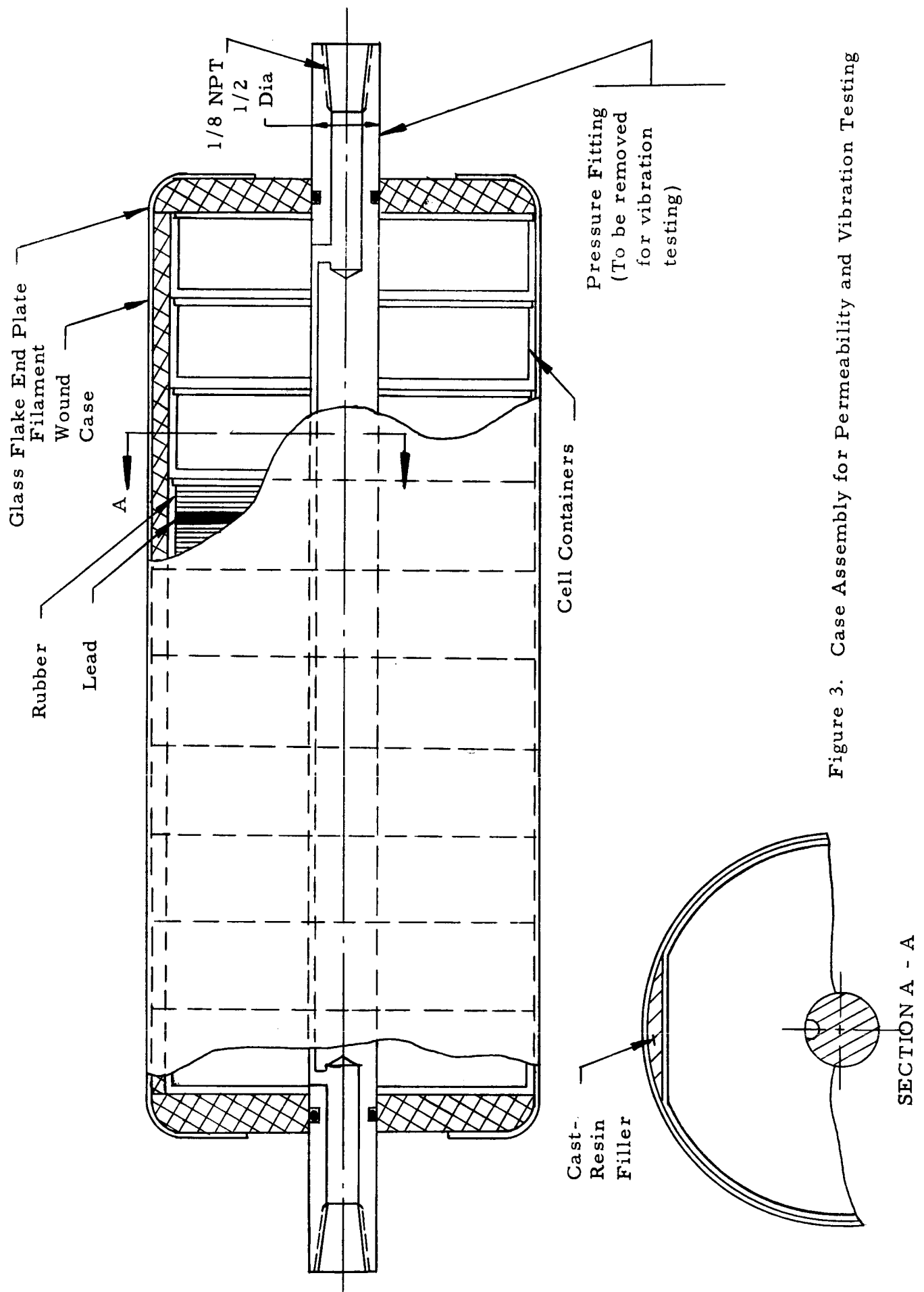


Figure 3. Case Assembly for Permeability and Vibration Testing

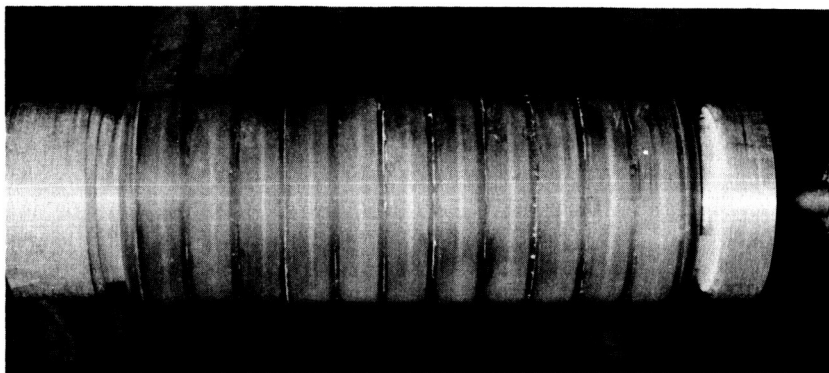


Figure 4. Cell Container Assembly
Prior to Case Winding

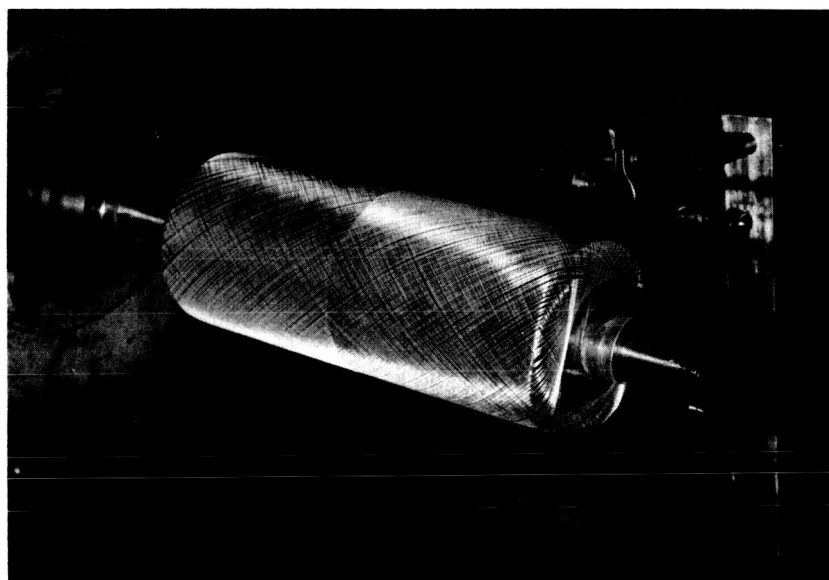


Figure 5. Winding Pattern of the
Dummy Battery

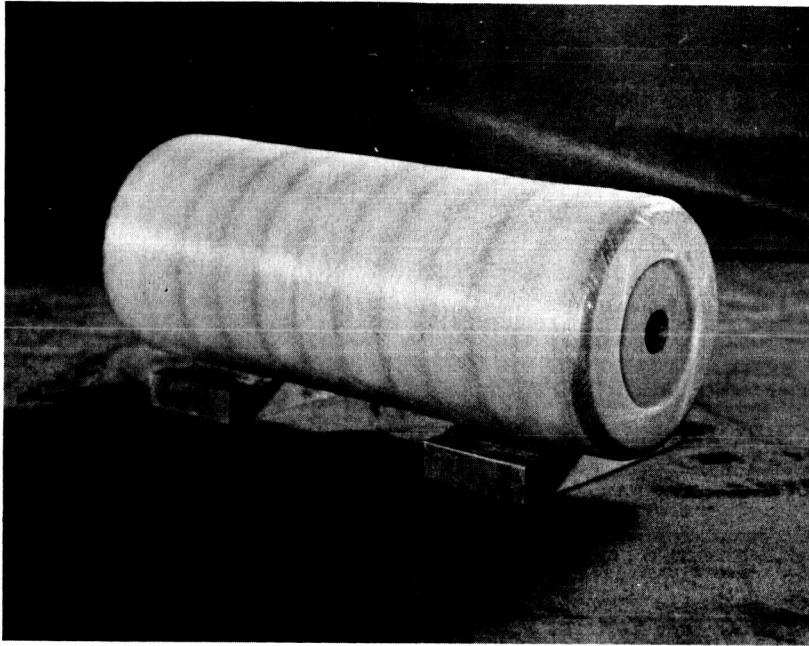


Figure 6. Dummy Battery No. 1 With Case No. 10